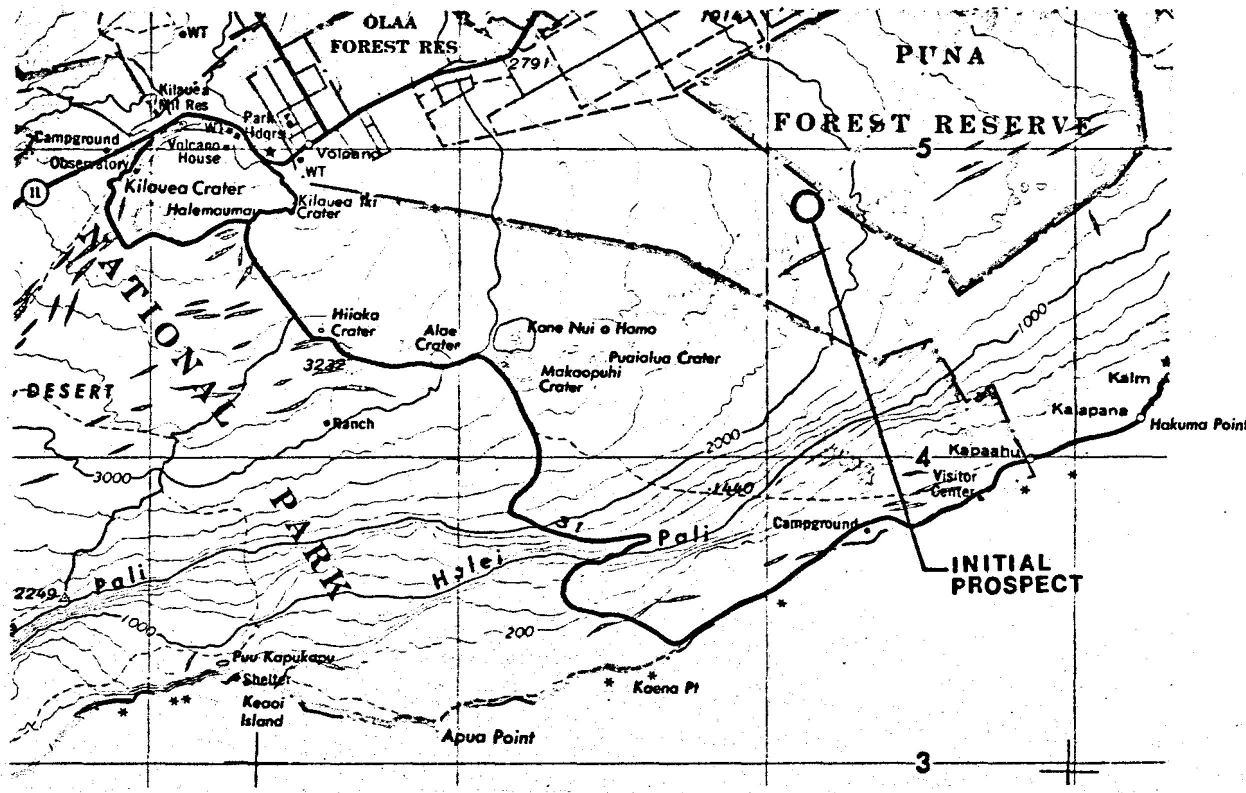
# QUALIFICATION PLAN
# FOR
# PHASE ONE
# OF
# TRUE-MIDPACIFIC GEOTHERMAL VENTURE

## JAMES CAMPBELL - KAHAUALEA PROJECT
## ISLAND OF HAWAII




JUNE 1981

S-81010-00

PRELIMINARY

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TRUE-MIDPACIFIC GEOTHERMAL VENTURE

ALA MOANA BOULEVARD, APT. 408

HONOLULU, HAWAII 96814

# JAMES CAMPBELL - KAHAUALEA PROJECT

# QUALIFICATION PLAN


Official Contact: H. A. True III, Partner
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P. O. Box 2360
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Date of Proposal: June 30, 1981

Proposal Expires:

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# TRUE-MIDPACIFIC GEOTHERMAL VENTURE

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## DIVISION I

## PROJECT SUMMARY

### 1.0 IDENTITY OF PROPOSER

This "Qualification Plan" proposal for Geothermal-Electric Power Development, Island of Hawaii, is submitted by:

True-Midpacific Venture
Honolulu, Hawaii

### 2.0 LOCATION OF RESERVOIR AND PLANT SITE

The objective of this project is to develop the geothermal resources of the James Campbell Estate, comprising ________ acres in the Puna District of the Island of Hawaii. The geothermal resource is assumed to exist in the vicinity of the East Rift of the Kilauea volcano. The location of the proposed geothermal well field and the geothermal-electric power plant are shown on Dwg. No. E-04-001. Access to the project area will be provided by a new road extension from the boundary road south from Glenwood on Highway 11.

## 3.0 STATUS OF OWNERSHIP AND LEASING ARRANGEMENTS

(To be completed by True-Midpacific)

## 4.0 RESOURCE DEVELOPMENT

(To be completed by Rogers - A brief description of resource production, conversion, disposal, $H_2S$ abatement and other environmental protection methods)

## 5.0 ELECTRIC POWER PRODUCTION

(To be completed by Rogers - A brief description of the proposed generating capacity and operating characteristics, such as minimum, normal, and maximum capacities, frequency and durations of scheduled maintenance, annual and daily load factors, including limitations on load-following and quick-load pickup and rejection.

## 6.0 RISK ABATEMENT - SEISMIC AND VOLCANIC

(To be completed by Rogers, with assist from Professor Helsley)

# 7.0 PROJECT ORGANIZATION AND TEAM'S QUALIFICATIONS

## 7.1 Organization

Midpacific Geothermal/True Geothermal Partnership

a. Midpacific Geothermal, Inc.

President - John P. Ellbogen
Executive Vice-President - R. B. Moss
Vice-President (Exploration) - Steve C. Champlin
Secretary/Treasurer - M. J. Darr

b. True Geothermal Energy Company*

General Partner - H. A. "Dave" True, Jr.
Partner (Operations) - H. A. True, III
Drilling Superintendent - Max E. Peden
*Subsidiary of the True Companies (see attached organizational chart)

Consultants

a. Lease applications, permitting and environmental assessments - Mr. Jack Keppeler

b. Geophysics Advisor - Dr. Charles Helsley, Director
Geophysics Institute, University of Hawaii
Honolulu, Hawaii

c. Resource evaluation and delineation - Geothermal resource analysis and well testing companies

d. Engineering Design - Rogers Engineering Co., Inc.

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## 7.2 Responsibilities of Participating Organizations

a. Midpacific Geothermal, Inc. - land acquisition, geothermal leases, permitting (State and County); environmental impact assessments; geophysical analysis of prospect areas and development strategy; coordination with public groups, governmental agencies and elected officials; administration and management; jointly responsible for marketing promotion and projections.

b. True Geothermal Energy Company - Drilling and transportation of equipment and supplies; exploration and drilling site selection; operations plans; drilling operations; resource evaluation and well testing; design and construction of gathering systems and pipelines; production operation and maintenance of fields and related facilities; construction of access roads and marketing facilities including power plants if necessary or applicable, marketing and downstream promotion.

c. Rogers Engineering Co., Inc. - Complete and comprehensive engineering consultation including (1) resource development, (2) design of gathering and disposal systems, electric power generating plants, $H_2S$ abatement facilities, and (3) power plant economics.

d. Other Consultants - As stated in 7.1 above.

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7.3 Qualifications of Team Members

a. Brief statement of Midpacific's qualifications

(By Midpacific)

b. Brief statement of True Geothermal's qualifications

(By True-Midpacific)

c. Rogers Engineering has been involved in geothermal energy development since 1961. Rogers has engaged in geothermal projects in the United States, Turkey, Philippines, Iceland, Costa Rica, and Iran. In those areas where the resource has been developed by leaseholders of geothermal reservoirs, Rogers has had many projects in which Rogers prepared well flow test data, feasibility study, and final design; procured equipment, materials, and construction contractors; and furnished construction management of the project. Rogers normally furnishes power plant start-up assistance, resulting in commercial operation of the electric power generating plant.

Included among Rogers' U. S. projects are the engineering design and construction management of the well re-work, well testing, and the power plant for the HGP-A Wellhead Generator for the R.C.U.H.

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d. Brief outline of Dr. Helsley's qualifications

e. Outline of qualifications of other consultants.

7.4 Principal Project Officer

The principal project officer for True-Midpacific Venture is:

Mr. H. A. True, III, Partner
True Geothermal Energy Company
P. O. Box 2360
Casper, Wyoming 82602

Mr. True is authorized to negotiate on behalf of the True-Midpacific Venture.

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## DIVISION II - TECHNICAL DATA

### 1.0 PROPOSER'S EXPLORATION AND DEVELOPMENT PROGRAM

1.1 GENERAL - About a year ago, we began an assessment of the geothermal resource potential of the Hawaiian Islands using available geological and geophysical data. The primary sources of this data were the geological maps and published reports by eminent geologists such as Dr. Harold Stearns and the late Professor Gordon Macdonald. We have combined with these data the published data from the geothermal reseearch group at the Hawaii Institute of Geophysics of the University of Hawaii and have used this combined data set and aerial photographs to arrive at an exploration strategy for most areas thought to have geothermal potential in the State of Hawaii, with special emphasis on the Big Island.

Kilauea volcano has two rift zones through which magma (molten rock) moves in the subsurface whenever volcanic eruptions take place in the lower portions of the rift. It is our belief that sufficient heat has been retained in the subsurface to make possible a viable geothermal resource. One of these zones of high volcanic activity passes through the Campbell Estate in the vicinity of Kalalua crater.

1.2 EXPLORATION - The East Rift zone of Kilauea volcano provides a good clue as to where we are most likely to succeed, based on the earlier geologic and geophysical studies of the Island of Hawaii, which were the basis for siting the successful HGP-A well. In order to further characterize the resource potential of our specific area, some onsight measurements of electrical and seismic activity will be utilized in addition to analysis of the magnetic fields in the region. We will have this necessary geophysical assessment completed prior to the time that the first drilling permits can be obtained. As the exploratory wells are drilled, a complete set of geophysical logs will be taken and the results used to calibrate the existing studies and those yet to be completed prior to drilling. As the data are refined from the drilling results, additional surveys will be carried out as indicated, such as electrical, seismic, gravity, magnetic, geochemical and geothermometric.

Our initial exploration effort will be to determine the existence of a resource on a large scale basis, as we believe the potential exists for over 100 MWe on the Campbell Estate alone. Various areas have been defined and those having the greatest potential will be tested first. Four areas of substantial potential exist on the Campbell Estate. We currently plan to commence our "wildcat" drilling in the area marked "Initial Prospect" on Dwg. E-04-001. Drilling sequence is assumed as follows: The first exploratory well,

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CE-1, will be drilled closest to the rift, and is assumed to be successful. The next exploratory well, CE-2, 2,000 ft. further away from the rift zone, is assumed to be successful. The next exploratory well, CE-3, 2,000 ft. further from the rift zone, is assumed to be a failure and will be used as an injection well if permeability is satisfactory. Well No. CE-4, between CE-1 and CE-2, is a development well and should be successful. No. CE-5 is an exploratory well and is assumed to be a producer. Successful completion of this planned program will result in a proven resource adequate to supply a 25 MWe power plant.

If a resource is discovered, a development plan as described below will be the basis for our development activity. If a resource is not discovered in the initial area, similar attempts will be considered in the other areas of Campbell Estate property and in the event of a discovery a similar, but modified development plan would be followed.

We plan to drill several holes between 8,000 and 10,000 feet in depth in the area. Once the existence of a resource is established, offset drilling will be conducted to determine the extent of the resource and its production capability. Since our goal is to find a

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reliable resource acceptable to HECO, we will begin our exploration efforts in an area relatively safe from possible loss by volcanic action.

A schedule for our exploration and development activities is attached as Figure 1. This plan envisages four phases of activity:

(1) Permitting and geophysical assessment (6 to 12 mos.).

(2) Exploration drilling (6 mos.)

(3) Well-testing and confirmation drilling (6 to 12 mos.)

(4) Field development and power plant construction (2 yrs. to 30 mos.)

Examination of this schedule leads us to believe that power production could begin by March 1985.

1.3 DEVELOPMENT - Our development plans for the Kahaualea property have identified a number of critical path elements commencing with the acquisition of the State mining lease. Once this has been acquired, we would prepare a preliminary environmental impact statement and begin our geophysical evaluations, road construction and site preparation. After a discovery is made, subsequent development will

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attempt to drill several wells from a single site in order to minimize the environmental disturbance created by excessive road construction. This will also facilitate testing and production of the wells.

Testing of the wells will follow a procedure similar to the most recent test of the HGPA well in Puna in which both noise and environmental pollution abatement was accomplished by use of a "sparging pit" and the injection of caustic soda to remove unwanted hydrogen sulfide gas.

During the production test, Rogers Engineering will monitor the production rate steam-water ratio, hydrogen sulfide content, salinity, fluid chemistry, and noncondensable gas content. All of these items are necessary to design an appropriate power plant and to devise an appropriate means of protecting the surface and subsurface environment, and will provide a data base that is necessary in order to convince HECO that this resource is the most acceptable of its various alternatives that will be presented to them.

Our exploration, testing, development and production efforts will be designed to be in compliance with all State regulations relative to air quality, noise abatement, and environmental standards.

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Once we have successfully completed our development efforts in the area of discovery, we envisage that exploration and development efforts will be undertaken on other portions of the Estate so that its resource can be assessed and developed to their fullest potential.

## 1.4 Determination of Initial Power Plant Size

(To be added by Rogers)

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## 2.0 RESERVOIR INFORMATION

(This section is held open for Dr. Helsley's new write-up after his return on June 2. His existing detailed write-up on the Puna geothermal resource may serve as a valuable annex).

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## 3.0 RESOURCE DEVELOPMENT AND CONVERSION FACILITIES

3.1 The planning and permitting required for full field development of a geothermal resource and the associated delivery and marketing facilities would commence early in the exploration phase and be refined or completed as the requisite information is obtained from the initial drilling and testing.

3.2 Additional development/production wells would be drilled in the principal discovery area to enable sustained production of not less than 25 MWe, such capability to be on line in advance of the desired on-line date prescribed by HECO.

3.3 The schedule for exploration and development indicates the accelerated time for the exploration and well development and the power generating plant. The drawings enclosed are as follows:

Perspective - Overall Power Plant

E-04-001 Area Location and Site Plan, with Energy Gathering System

## 3.4 Resource Production, Supply and Disposal Systems

For an initial installation of a 12.5 MW power plant a resource production from three active wells and one reserve (spare) well

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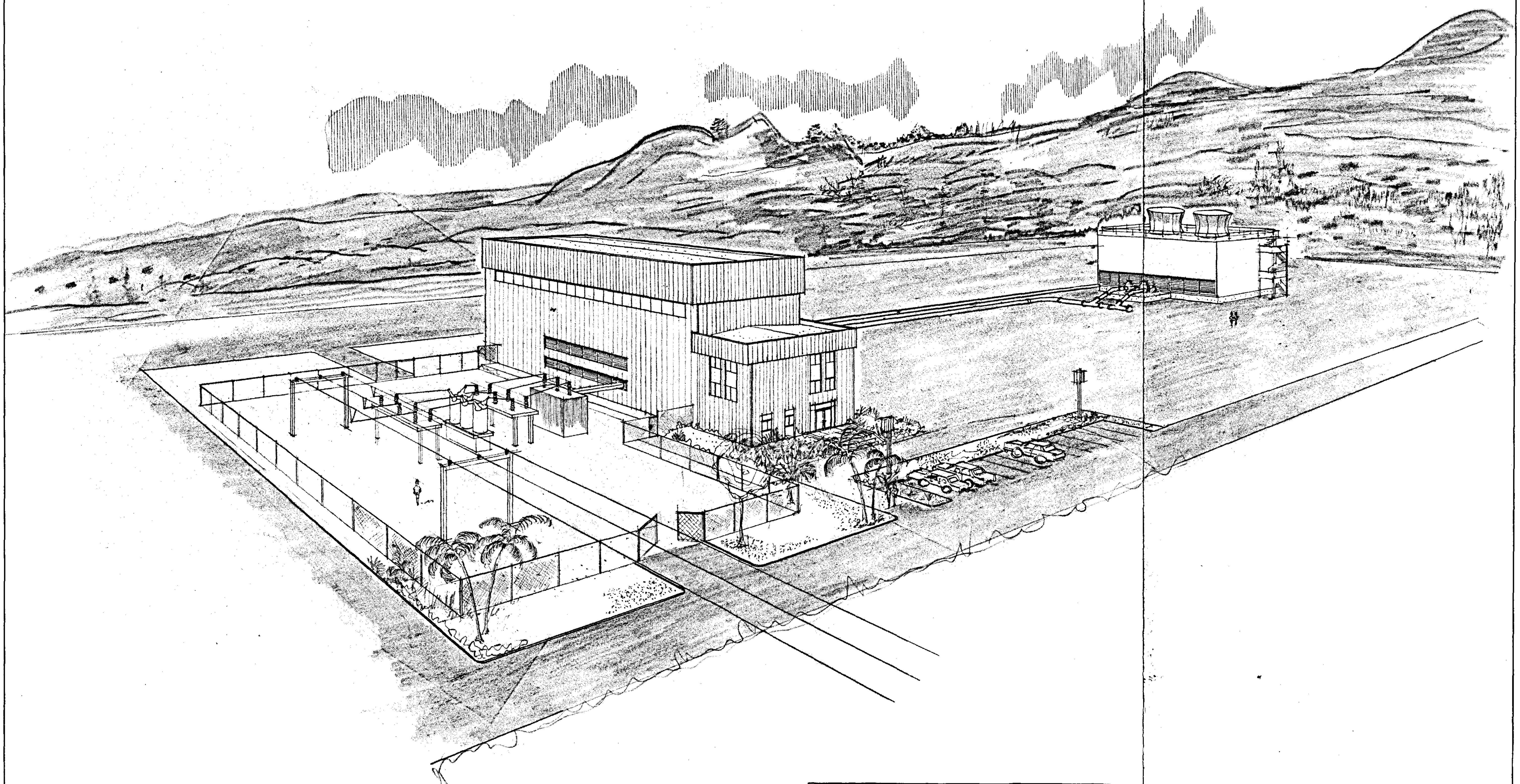
would be required. The disposal of residual brine after production steam removal would require one injection well. Prior to injection the brine would be cooled in ponds to drop out silica. The cooled brine would be mixed with the spent caustic stream from the $H_2S$ abatement system and the neutralized cooling tower blowdown and pressured through polishing filters into the injection well.

## 3.5 Steam Production Variation (Turn-down Capability)

Because the production is made up of flash steam and brine the response of the production system to transient flow changes will not be instantaneous. It is estimated that a suitably designed piping and flashing system can be developed for the final design which can respond to a 50% turn down in less than six hours. Load shedding would require some venting of production steam which would have separate abatement equipment for $H_2S$ control. Provided an environmentally acceptable injection well is developed, all the $H_2S$ abatement could be accomplished by neutralizing with caustic soda all the stream flows containing $H_2S$. The $H_2S$ would then be injected in the chemically-bound condition as soldium sulfide ($Na_2S$). For the 12.5 MW installation, $H_2S$ abatement would require a gas scrubbing system in addition to the emergency steam venting abatement normally provided for start-up and shutdown emergencies. The estimated cost of this gas scrubber is $100,000 (1981).



| ROGERS ENGINEERING CO., INC.<br>ENGINEERS - ARCHITECTS<br>111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111 | TRUE-MIDPACIFIC VENTURE | PROPOSED 12.5 MW GEOTHERMAL POWER PLANT<br>PUNA DISTRICT HAWAII<br>PERSPECTIVE |
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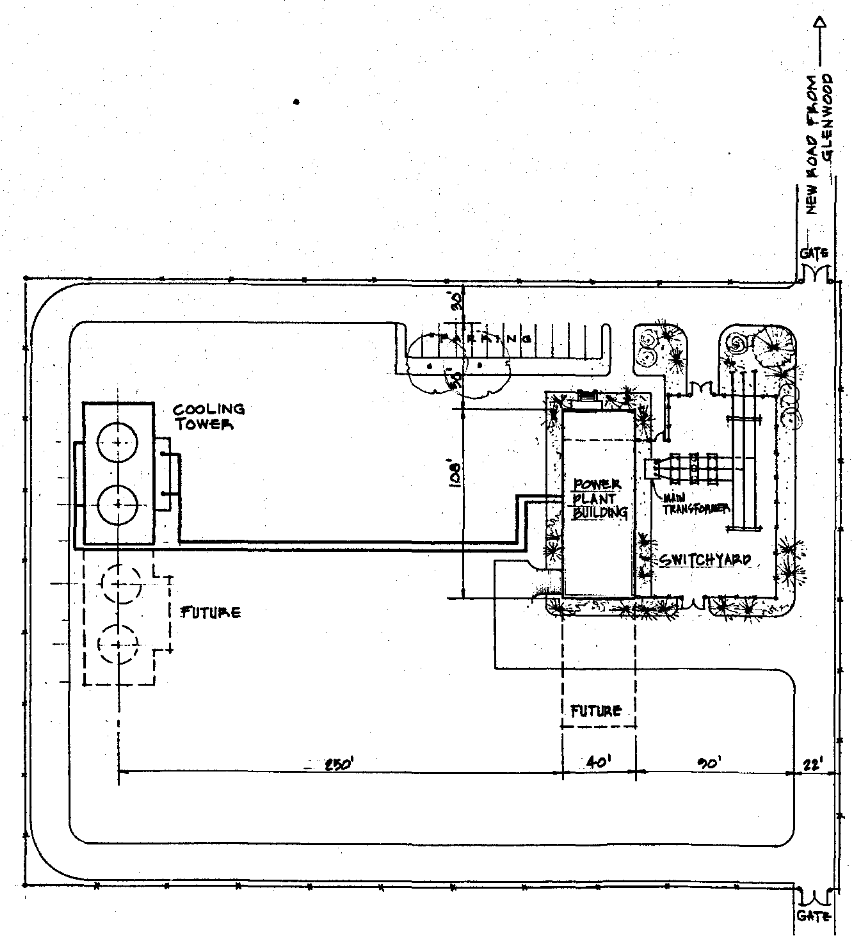
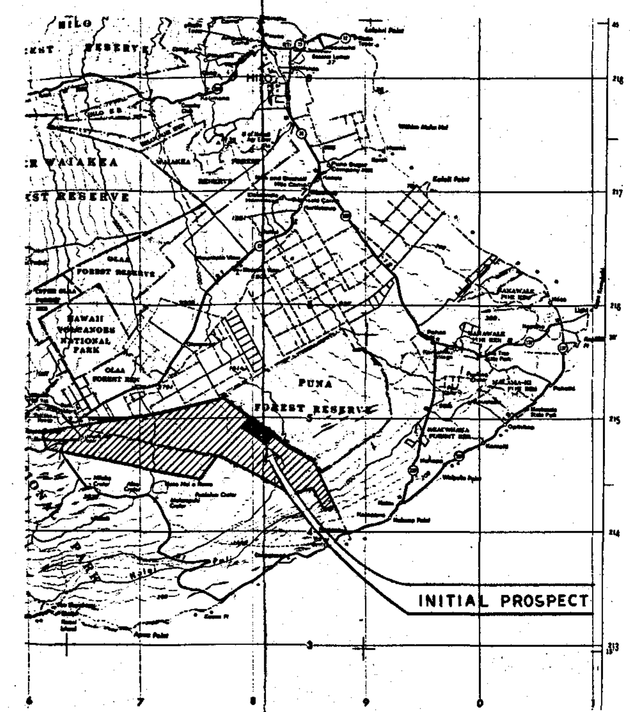
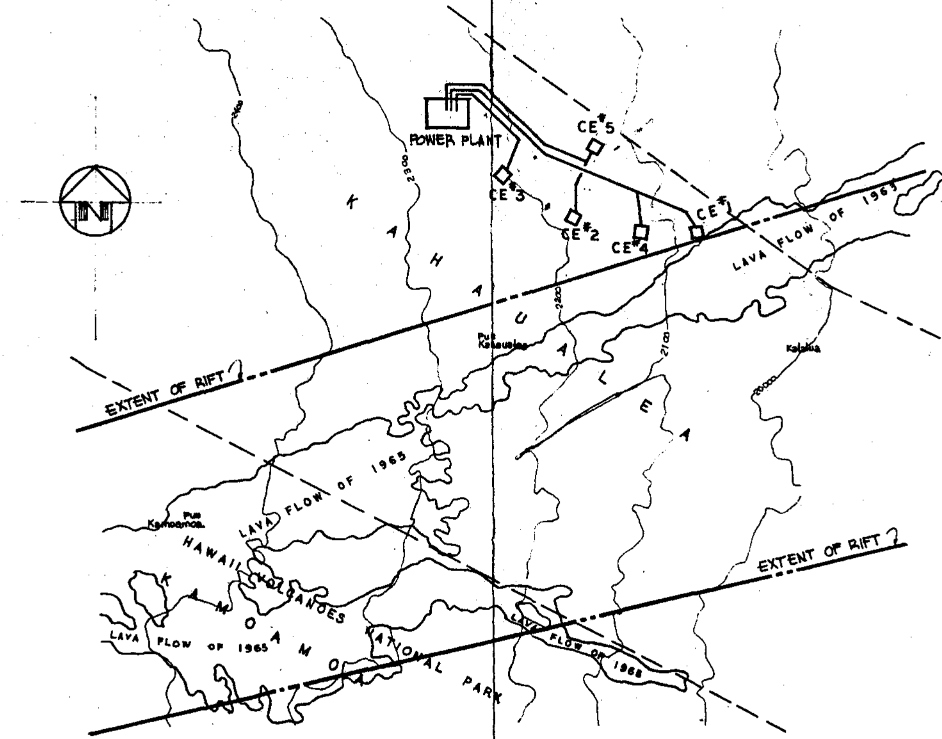
| DR. CHK. ENG. APPROVED | | JOB NO. S 81010-00 REV. |




POWER PLANT SITE PLAN
1" = 40'




VICINITY MAP
SHOWING TRUE - MIDPACIFIC DEVELOPMENT ACREAGE
SCALE 1:250,000




LOCATION MAP
INITIAL PROSPECT
SCALE 1:24,000

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| DR. GO. CHK. ENG. APPROVED | |

PROPOSED 12.5 MW GEOTHERMAL POWER PLANT
PUNA DISTRICT HAWAII
SITE PLAN & LOCATION MAP

JOB NO. S 81010-00 | E-04-001 | REV. 0

REFERENCE DRAWINGS | REV. | DATE | REVISION | ENG. | CHK. | RECO APPR. | CLIENT APPR.

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## 4.0 POWER PLANT INFORMATION

The power plant is to be designed for two (2) 12-1/2 MWe geothermal steam electric power generating units. It is anticipated that Unit No. 1 would be first installed and would meet the project schedule for on-line power in March 1985. The second unit would then follow after obtaining operating experience on the first unit.

The actual final design of these plants will be based upon production well flow test data.

At this stage of submitting an RFP the best method of illustrating the appearance of the plant, etc., we feel is presented in the attached drawings:

| | |
|---|---|
| E-04-002 | Power Plant - Floor Plans |
| E-04-003 | Power Plant - Elevations & Sections |
| E-03-001 | Flow and Control Diagram |

## 4.1 General Description

The steam turbine will be a single pressure, single flow, impulse type condensing unit with single cylinder, direct-coupled to a totally enclosed are cooled generator.

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| | |
|---|---|
| Minimum Capacity | 3,000 kW Gross Generation |
| Normal Capacity | 12,500 kW Gross Generation |
| Maximum Capacity | 12,500 kW Gross Generation |
| | |
| Minimum Capacity | 2,670 kW Net Generation |
| Minimum Capacity | 11,125 kW Net Generation |
| Minimum Capacity | 11,125 kW Net Generation |

Initially one unit will be installed with provision for purchase and installation of the second similarly sized unit, following satisfactory experience with the wells, twenty-four months after first unit installation.

Maintenance will require a total of 5 weeks per year of which 4 weeks will be required for the annual scheduled turbine and plant overhaul.

Annual load factor is assumed as a minimum of 80% with a daily load factor of 90%.

The unit will be capable of load following within its design upper and lower load limits. The maximum rate of change of load, increasing or decreasing, will be 0.625 MW/minute per unit. The load change will be accomplished in the first instance by steam rejection. For a long period running at reduced load the well output will be curtailed. (See Sec. II - 3. - Resource Development and Conversion Facilities, for maximum turn-down possible for wells).

## 4.2 Design Basis

This section describes the design basis for the power plant, the operation of the power cycle, the development of the site, the layout of the building, the operating equipment, and the high voltage substation. The following design plan is based on site and resource data received to date. It is recognized at this time that some of the data is preliminary and may be modified by subsequent investigation.

### 4.2.1 Turbine-Generator System

The turbine-generator will be a single pressure admission condensing unit. The equipment includes all the necessary automatic tripping devices required to protect the unit when a malfunction occurs.

The turbine blading will be stiff and short with stress levels considerably lower than those supplied for comparable fossil fuel steam turbines and will utilize those features which will result in

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long term reliable service with geothermal steam. Corrosion resistant materials will be specified for turbine internals in contact with geothermal steam.

The generator supplied with the turbine will be designed in accordance with the latest standards of ANSI C50.10-75, and C50.13-1975 and applicable NEMA and IEEE standards.

### 4.2.2 Cooling Water System

Makeup water will be provided from deep wells.

### 4.2.3 Condensate System

The condenser will be designed and constructed, where applicable, to conform with the latest ASME Code and will be of the surface type. The condenser will be constructed of 316 SS clad carbon steel. Internal parts such as tubes and tube plates will be stainless steel. Water boxes will be carbon steel with epoxy coating. The liquid level in the condenser is controlled by automatic liquid level controller. All the condensate from the geothermal steam is to be returned to the cooling tower.

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Details of the condensate system may be found on Sheet ______ and details of the noncondensate gas system may be found on Sheet _____.

### 4.2.4 Auxiliary Systems

All necessary auxiliary systems will be supplied in addition to the major systems of the power plant, and will be designed specifically for the special conditions imposed by the utilization of geothermal steam and the site environment. The auxiliary systems include, but are not limited to, the following:

Auxiliary Cooling Water System
Turbine-Generator Lubricating Oil System
Instrument Air System
Fire Protection System
Noncondensable Gas Removal System

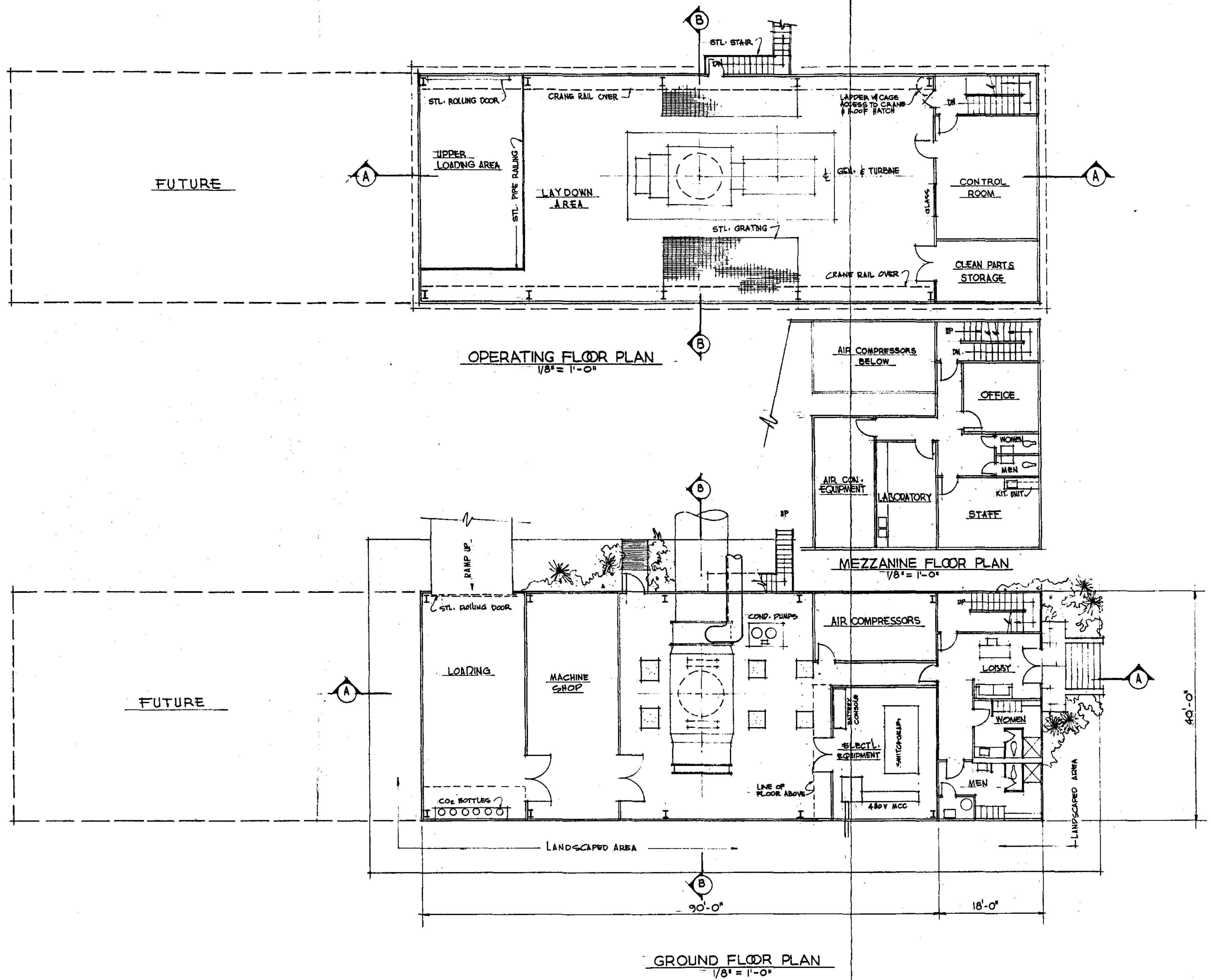
The auxiliary systems and components are described in detail in subsequent paragraphs of this section. The turbine-generator lubricating oil system is a part of the turbine-generator supplied equipment.

### 4.2.5 Electrical

The generator and generator switchgear will provide power at 13.8 kV to the main transformer which will step the voltage up to 161 kV. Plant auxiliary loads will be supplied at 480 volts from the auxiliary transformer, which receives power at 13.8 kV. The 480 volt system is provided for the cooling water pumps, air compressors, chemical feed pump, cooling tower fans, turbine lubricating oil pumps, the fire protection system, lighting, air conditioning, and other plant utilities. The equipment which is essential to reliable power plant operation is connected to one 480 volt bus; the balance of plant electrical equipment is connected to another 480 volt bus.

### 4.2.6 Controls and Instrumentation

A main control panel in the control room will contain electrical and pneumatic controls for the various electrical and auxiliary process systems. In general, pneumatic systems will be used for level, pressure, flow and valve controls. Pneumatic transmitters in the field will provide inputs to the panel mounted instruments. Resistance temperature detectors will provide electrical temperature signals from the field to solid state electronic temperature indicators and controls. Electric control will be used for turbine-generator, switchgear and motors.

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TRUE-MIDPACIFIC VENTURE

APPROVED DATE

PROPOSED 12.5 MW GEOTHERMAL POWER PLANT
PUNA DISTRICT HAWAII
FLOOR PLANS

JOB NO. 581010-00

E-04-002

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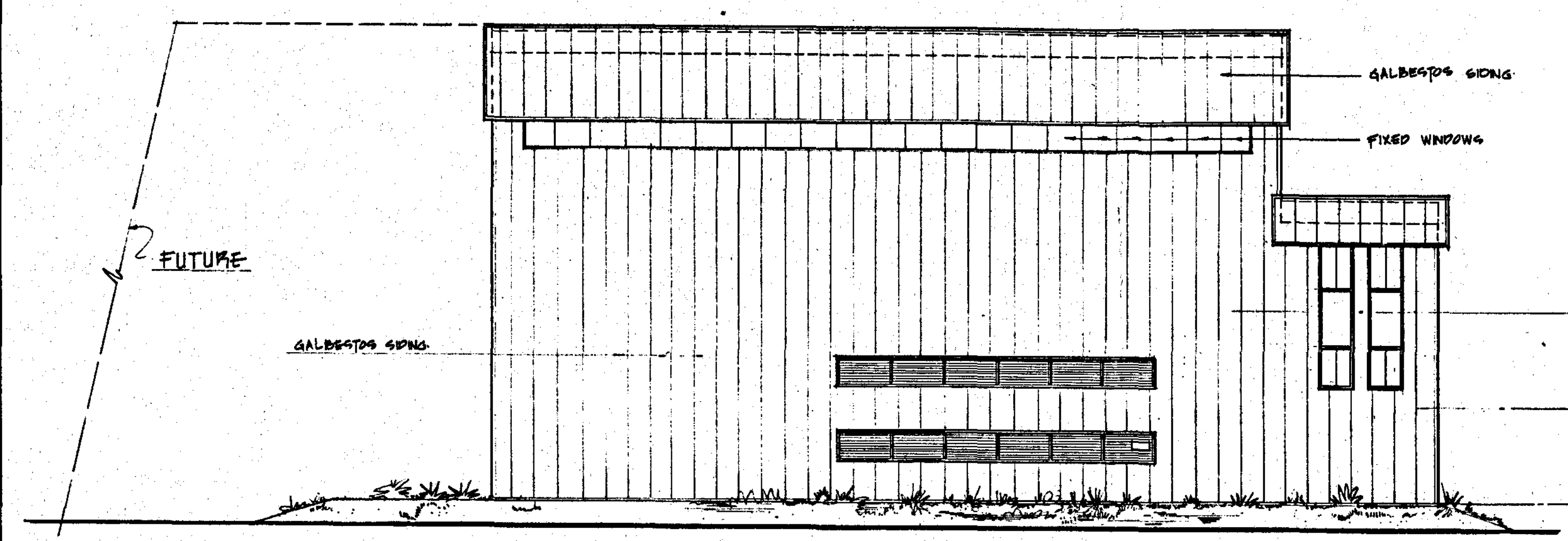
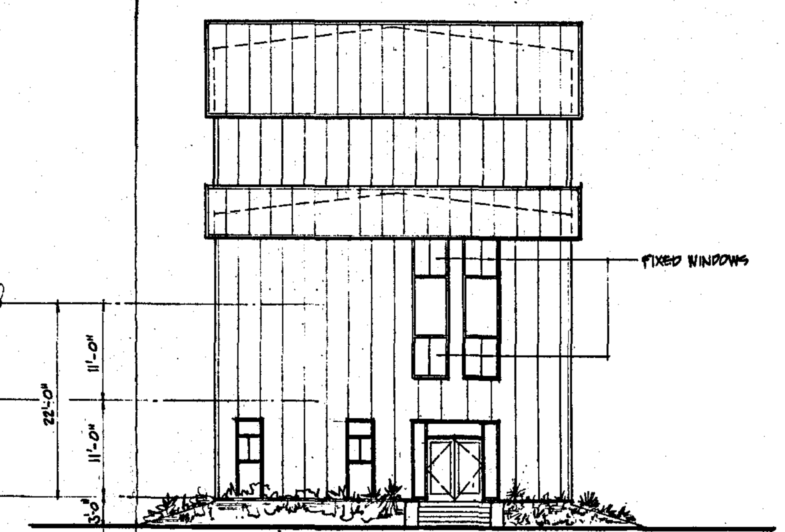
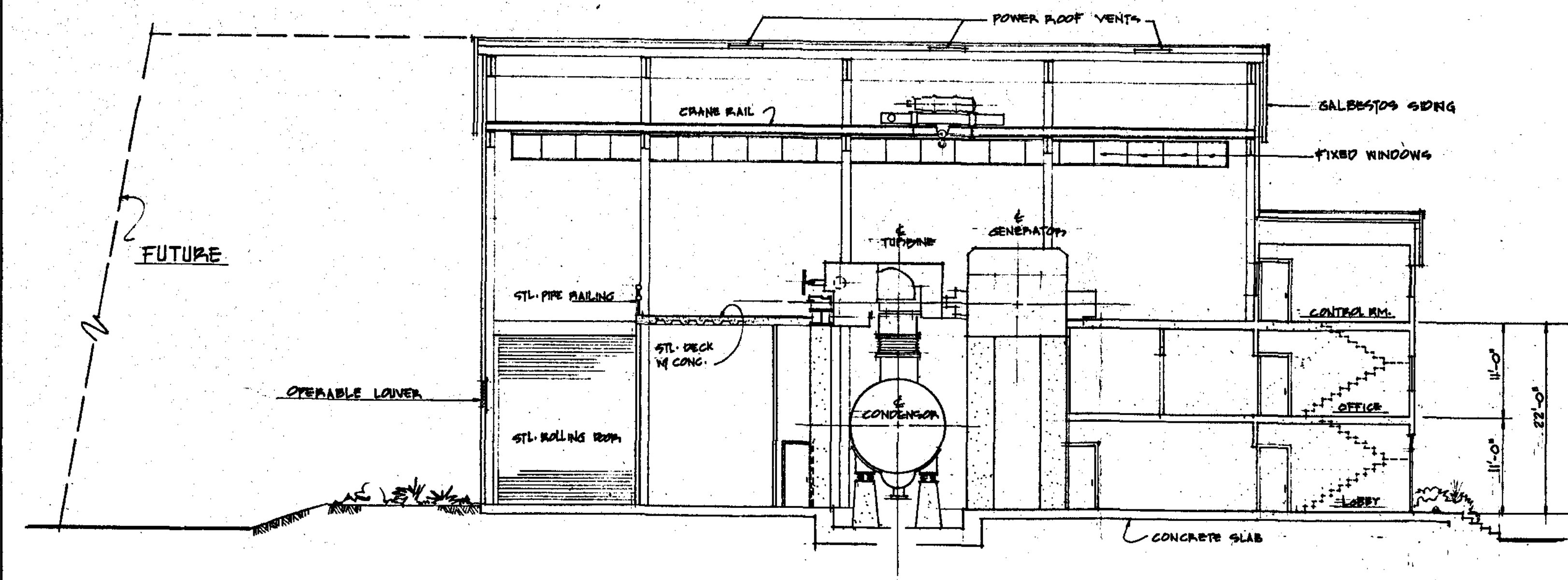


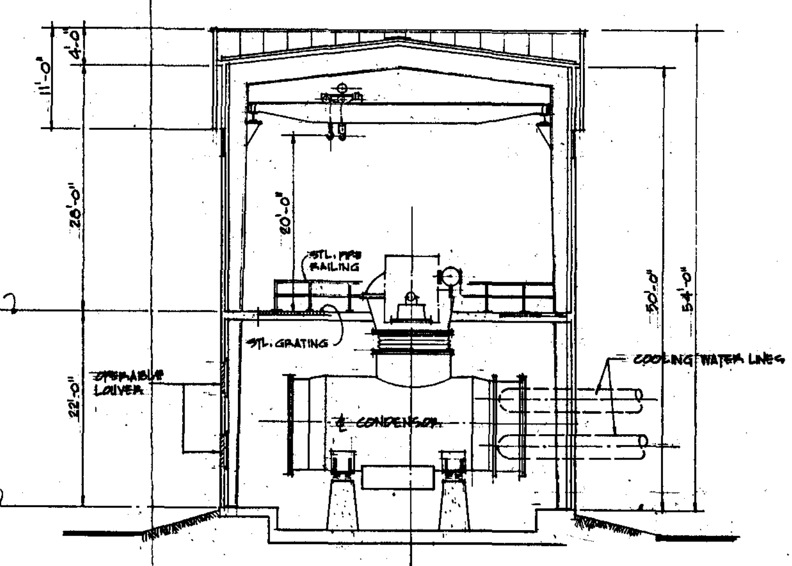

SIDE ELEVATION
1/8" = 1'-0"




FRONT ELEVATION
1/8" = 1'-0"




SECTION A-A
1/8" = 1'-0"




SECTION B-B
1/8" = 1'-0"

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TRUE-MIDPACIFIC VENTURE

APPROVED ______ DATE ______

PROPOSED 12.5 MW GEOTHERMAL POWER PLANT
PUNA DISTRICT HAWAII
ELEVATIONS & SECTIONS

JOB NO. S81010-00
E-04-003
REV. 0

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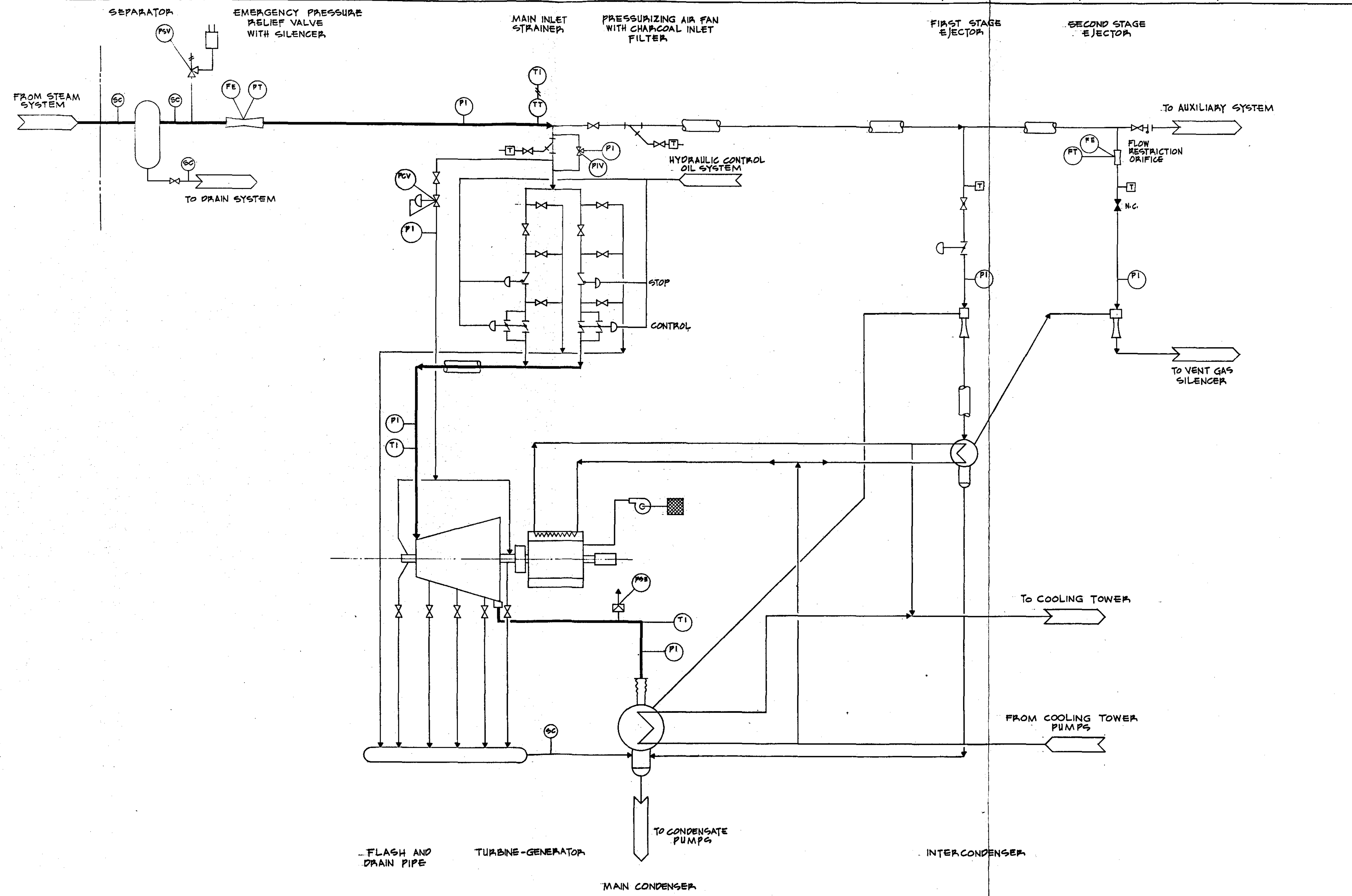
## 4.3 Process Description

The following paragraphs provide elementary descriptions of the steam cycle, circulating water system, steam condensate system, and exhaust of noncondensable gases. Taps will be located on these piping systems in order to withdraw samples of steam, conensate, noncondensable gases and cooling water. A technical laboratory organization will be retained to take these samples and perform chemical analysis as required.

### 4.3.1 Steam Cycle

Steam from the gathering systems is supplied to the plant steam lines at the plant boundary. A steam line pressure relieve system will be installed for emergency shutdown of the turbine-generator. Steam is piped to the turbine, and in smaller quantities, to the turbine gland seals, first stage noncondensable gas ejector and second stage noncondensable gas ejector. Turbine steam is exhausted at 4 in. Hg Abs. downward to the shell side of a surface condenser. Cooling water flow through the horizontal condenser tubes is in a multipass arrangement.

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PROPOSED 12.5 MW GEOTHERMAL POWER PLANT
PUNA DISTRICT HAWAII
FLOW & CONTROL DIAGRAM

JOB NO. S81010-00 E-03-001 REV. 0

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Discharge from the first stage (main condenser) steam jet ejector enters an intercondenser where noncondensable gases are drawn off by a vacuum compressor discharging to the atmosphere through a silencer. In the event of vacuum compressor malfunction, a second stage steam jet ejector is provided which exhausts to atmosphere through the same silencer.

### 4.3.2 Steam Condensate System

Surface type condensation equipment was selected for the concept design to permit extraction of the noncondensable gases for environmental cleam up by chemical or incinerator process.

Condensate from the intercondenser flows by vacuum pressure differential to the main condenser. Two full capacity transfer pumps (one spare) are provided to pump the condensate from the main condenser to the cooling tower basin.

### 4.3.3 Cooling Water System

The source of cooling water makeup is from deep well pumps located near the power plant.

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Two 60% capacity main circulating water pumps are provided to pump cooling water from the cooling tower forebay through the main condenser, intercondenser, generator heat exchanger, lube oil cooler, air compressor cooling system, and back to the sprays in the cooling tower. These main circulating water pumps operate when the turbine-generator is operating. An auxiliary cooling water pump is provided to supply cooling water to essential heat exchangers when the turbine-generator is shut down. Blowdown is required and is based on four concentrations of treated makeup water and discharges to a drain or percolation pond.

4.3.4 Noncondensable Gas System

From the data furnished the noncondensable gases consist of 0.2% by weight of the total steam flow. This value was used for establishing a Flow Diagram.

## 4.4 Building and Site

4.4.1 Building

The power plant building will comprise a two-story structure, 90' x 40', fully enclosed, approximately 50' high in combination with a three-story control/administrative support module, 40' x 18'. The control/

administrative module will be located on the north side of the main building. The turbine-generator building and equipment arrangements are shown in Drawings No. E-04-002 and E-04-003.

The enclosed building approach is preferred for the following reasons:

(a) Ease of maintenance on the turbine.

(b) Equipment protection against dust and corrosive effects.

The ground floor slabs will be constructed on engineered fill and will assume an elevation of 3' above normal grade. The main operating floor, 22' above the ground floor, will comprise steel framing with a concrete-filled steel deck designed for 250 psi. Certain areas will have steel grating. The general structural arrangement of the main building will be rigid steel frame designed on ± 24' bays, with girts and purlins respectively to accommodate galbestos, or similar, wall and roofing panels. A 20 ton bridge crane will be incorporated to traverse the entire length of the building, with main hook height ± 20' above the operating floor.

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The ground floor of the plant building proper will accommodate the following areas and major equipment:

1. Loading and Unloading
2. Machine Shop
3. Main Condenser
4. 4.16 kV Volt Switchgear
5. 4.16 kV Motor Control Center
6. Air Compressors
7. 69 kV Switchgear

The loading area located at the west end will effect access via a 14' x 16' rolling steel door at the northwest corner of the building.

The operating level will accommodate the following areas and equipment:

1. Turbine-Generator
2. Lay Down Area
3. Clean Parts Storage

To suit the functional requirements of the bridge crane in connection with the turbine-generator maintenance and access to the lay

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down area, the ground floor loading area will be open for the full height of the building and open to the operating floor.

Fixed windows will extend the full length of the main building on the upper east and west walls. The plant generated heat will be dissipated using a system of operable wall louvers in conjunction with open steel grating at the operating level, and roof mounted motor-operated discharge fans.

The ground floor of the control/administrative module will accommodate the following areas:

1. Main Entrance/Reception Lobby
2. Men's and Women's Restrooms
3. Janitor Supply Room

The second level (mezzanine) of the control/administrative module will accommodate the following areas:

1. Administrative Office
2. Staff Room
3. Rest Rooms
4. Laboratory
5. A/C Equipment

These areas encroach upon the Main Building, effecting a mezzanine between ground floor and operating floor.

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The upper floor of the control/administrative module accommodates the Control Room and Clean Parts Storage.

A staircase adjoining the lobby will effect access between the floors of the control/administrative areas and the floors of the main plant building. A second stairway located on the west side of the operating floor will permit exit from upper floor areas.

Instrumentation equipment enclosures, switchgear room and associated electrical equipment, and enclosed personnel areas will be air conditioned and slightly pressurized to maintain a positive air flow of clean filtered air from the equipment and personnel areas to the exterior.

A concrete pedestal on rigid mat foundation will support the turbine-generator and main condenser units. The pedestal will be of ample rigidity such that no resonance in the natural frequency of the pedestal foundation and the turbine-generator unit will occur.

### 4.4.2 Site

A plot plan of the proposed 12.5 MW Geothermal Power Plant area is shown on Drawing No. E-04-001. In addition to the power plant building the overall arrangement includes the following:

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1. Switchyard
2. Cooling Tower
3. Paved Perimeter Road
4. Perimeter Fence and Gates
5. Parking Area for 12 Cars

The overall site plan indicated shows an area of approximately 3.5 acres which includes provision for an additional 12.5 MW unit and a corresponding increase in the cooling tower capacity.

## 4.5 Electrical System

The electrical system is described in this section and a Single Line Diagram and the Single Line Meter & Relay Diagram are included in the Appendix A.

### 4.5.1 Substation

Electric power generated at 13.8 kV is transmitted to the transmission line through a main step-up transformer. The transformer is connected to the line through a group operated disconnect switch which will be equipped with a high speed grounding switch. The grounding switch is to be operated only in the event of transformer malfunction. Transmission line faults will be cleared by a 13.8 kV circuit breaker. The transformer will be a standard open bushing unit, oil filled and equipped with fans. Space will be provided in the switchyard for a future bus and circuit breakers if found to be necessary.

### 4.5.2 Station Service

The 13.8 kV station bus is connected by an air circuit breaker to the generator and the low voltage side of the main step-up transformer. This bus also supplies power to the auxiliary transformer and to the steam gathering and injection pump system through fused load break switches. The 13.8 kV bus will consist of an assembly of metal-clad drawout circuit breakers and fixed position fused switches. The metal-clad switchgear will have a 500 MVA interrupting capacity. A grounding transformer and resistor will be provided since the main step-up transformer will have a 13.8 kV delta winding.

The auxiliary transformer steps the voltage down from the 13.8 kV bus to 480V in order to supply the 480V switchgear and a motor control center. The auxiliary transformer will be of the unit substation type with fans and a 55/65°C rise. Capacity has been derated due to high ambient temperatures. The various pumps, cooling tower fans, small motors and a transformer for house lighting and other low voltage power requirements are supplied by the 480V motor control center. The 480V motor control center bus is split into a normal and critical load bus. The latter bus has limited capacity and feeds the lighting transformer, air conditioning units, plant sump pumpsm turbine auxiliary oil pump, instrument air compressors and other small critical motor loads. This bus is fed through a transfer switch either from the 480V motor control center normal bus or from a separate reserve transformer.

The 480 volt switchgear consists of a metal-clad assembly of low voltage large air circuit breakers which will be used as starters for motores larger than 200 hp. Switchgear will be bus connected to the auxiliary transformer.

### 4.5.3 Start Up

During start up, the generator is isolated from the 13.8 kV bus by opening its main breaker. The transmission line feeds power through the main transformer to the 13.8 kV bus to supply start up power. When the generator has reached rated speed and voltage, the generator will be synchronized with the bus and then the main breaker closed, thereby bringing the plant into normal operation with no interruption of power to station auxiliaries.

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## 4.6 Plant Output Including Auxiliary Loads

Gross Plant Output:

| | |
|---|---|
| First Unit | 11.125 MW |
| Second Unit (30 months later) | 11.125 MW |

Auxiliary Load (for one unit)

| | |
|---|---|
| Power Plant | 800 kW |
| Gathering | 75 kW |
| Injection | 500 kW |

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# 5.0 HAZARD ABATEMENT

## 5.1 General Background

Geothermal resources in the Puna district owe their existence to the recent volcanic activity of the region. Without this constant "resupply" of heat to the system, it is unlikely that the resources would have been as extensive or as economically attractive as they are thought to be based upon the results of HGP-A. This volcanic activity that is responsible for the resource also creates a certain degree of hazard in the form of earthquakes and the risk of volcanic eruption. Any geologically young area has similar risks, e.g., the San Andreas Fault system in California that affects the cities of San Francisco, and Los Angeles as well as the geothermal development in the Imperial Valley; the volcanoes of the Cascades, Central America and the Philippines, the latter two of which have successful geothermal plants in the shadows of the active volcanoes, and Iceland where the geothermal plants are on an active rift zone considerably more hazardous than any in Hawaii. The issue is to not avoid geologically young areas, but to use adequate safeguards in the detailed evaluation to reduce the risk to an acceptable level.

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## 5.2 Detailed Hazard Abatement Study

A qualified firm of engineers experienced in hazard and risk assessment for areas of high volcanic and seismic risk will be engaged to develop a detailed site-specific study of the potential reservoir and power plant locations.

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## 6.0 ENVIRONMENTAL INFORMATION

### 6.1 Disposal of Excess Fluids

Although a permit has been granted for the surface disposal of brine and excess condensate at HGP-A, it is not expected that this practice will be either permitted or desirable for a larger installation such as that envisaged in this proposal. Fortunately, ample opportunity for the subsurface disposal of fluids, and excess condensate if necessary, is available throughout this portion of Hawaii as described below.

Subsurface disposal of fluids requires several conditions to be met:

(1) The fluid must be disposed of at a depth where it will not be hazardous to the potable ground water.

(2) A porous, high permeability zone is desired and

(3) The fluid must not precipitate minerals in the immediate vicinity of the well bore.

The primary mineral likely to precipitate is silica ($SiO_2$) which in itself is not harmful and, in fact may be a valuable by-product

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since it is deficient in most Hawaiian soils. After treatment for the stabilization of $H_2S$, the silica in the brine will precipitate naturally bypassing the hot brine through a surface holding tank prior to injection.

Thoughout Hawaii the lavas formed in the subaerial (above sea level) portions of the island consist of very porous and permeable materials such as pahoehoe, aa-aa, and cinders (spatter cones). So far as is known, this material forms all of the above sea level portions of the islands except for local dikes emplaced in the immediate vicinity of the rift zone. Below this porous zone lies the dense low permeability pillow lava zone in which the geothermal reservoirs are located. Drilling at HGP-A demonstrated that this very porous material extends below sea level for about 1,000 feet due to the subsidence of the island during the formation of the above sea level portion of the island. In the area we propose to develop it is believed that this boundary is somewhat deeper, perhaps as deep as 2,000 ft. below sea level. Thus, disposal of brine can readily be accomplished by drilling a hole into the lower portion of this porous zone at a depth of 1,000 to 2,000 ft. below sea level. At this depth, there is still high permeability and so there is little or no chance of a brine, whose density will be greater than fresh water, rising to the surface of the fresh water Ghyben-Herzberg lense.

Although it may be necessary to drill special wells for disposal purposes, it is more likely that the disposal wells will be "cold" or unsuccessful wells drilled near the margin of the producing geothermal field. Because of the strategy of locating the field development as far as possible from the active portion of the rift zone, it is likely that at least one, if not several, "unsuccessful" geothermal wells will be drilled. In this case, the waste brines can be injected at a depth equivalent to the producing reservoir provided that there is sufficient permeability.

## 6.2 Other Environmental Impacts

Action will be initiated in coordination with University of Hawaii personnel to establish base line stations for environmental monitoring around the leased property. (The collection and measuring of base line environmental data is essential prior to commencement of drilling to assure that any impacts from drilling and production operations can be identified.)

A qualified engineering firm based in Hawaii will be engaged to plan and monitor environmental compliance according to the standards established for the well HGP-A.

ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITECTS
111 PINE STREET
SAN FRANCISCO, CALIF. 94111

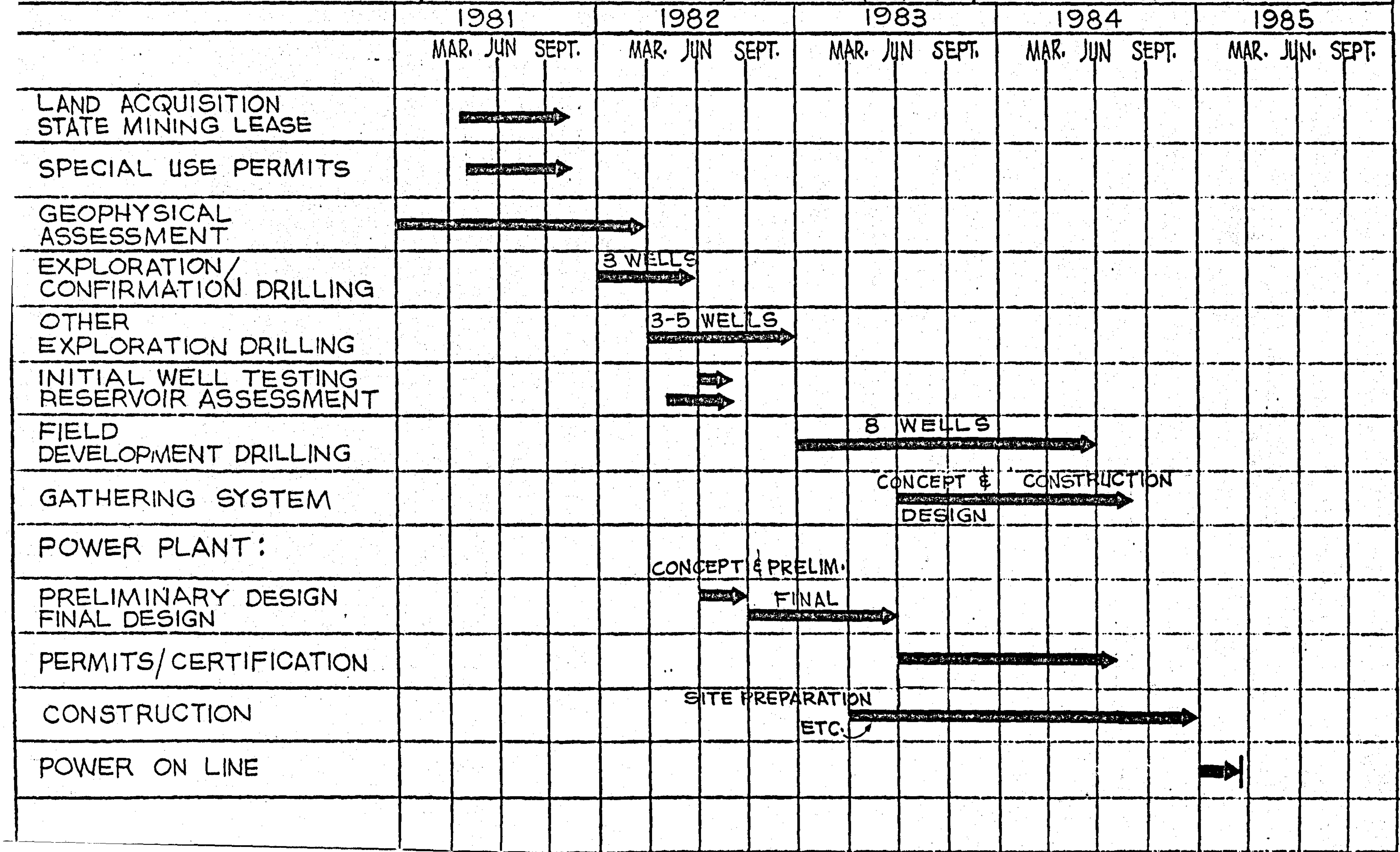
JOB NO.
S 81010 -00

DATE:

# PRELIMINARY SCHEDULE

**PROJECT :** TRUE-MIDPACIFIC GEOTHERMAL VENTURE
CAMPBELL ESTATE - KAHAUALEA PROPERTY

SCHEDULE FOR EXPLORATION AND DEVELOPMENT
12.5 MW GEOTHERMAL POWER PLANT



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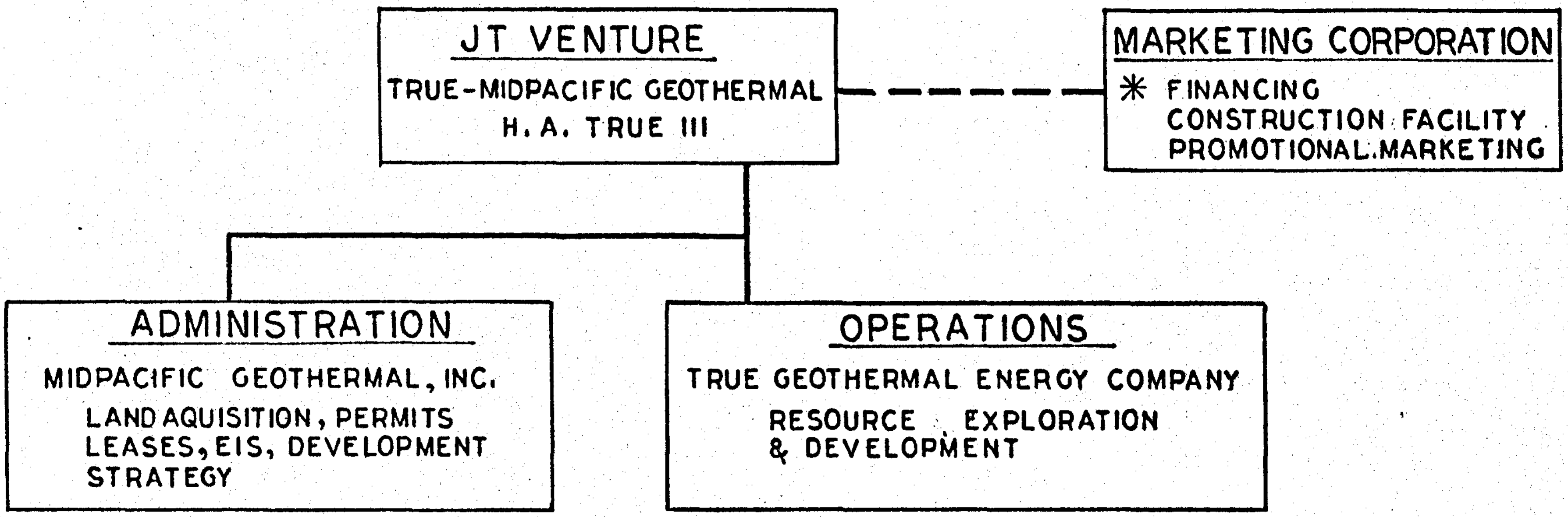
## DIVISION III - MANAGEMENT DATA

1.0 ORGANIZATION CHART
(Included)

2.0 JOINT VENTURE AND SUBCONTRACTS

3.0 QUALIFICATIONS




* JT VENTURE WITH DEVELOPER, LANDOWNER, UTILITY CO.

# PROJECT ORGANIZATION

TRUE-MIDPACIFIC GEOTHERMAL VENTURE

DATE 5-19-81
S-81010-00

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# DIVISION IV - BUSINESS PLAN

1.0 JOINT VENTURE PARTICIPANTS
(Data by True-Midpacific)

2.0 ANNUAL VOLUME

3.0 BANK REFERENCE

4.0 CLIENT REFERENCES

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## DIVISION V - ECONOMIC CONSIDERATIONS

This section presents the economic framework of the proposal at the qualifications stage of the overall HELCO project interest. It is recognized that at the end of the second phase a negotiation will take place to settle the final numbers.

### 1.0 PROJECT OFFER

The offer is to provide electricity generated from geothermal resources to HECO for a specified unit price to be finalized at a later date.

1.1 The project offer is for sale of electric energy (77.8 million kWh) and up to 11.1 MW of demand from Unit 1 starting in March 1985 according to the diagram 5-1 derived from the R. F. P. Exhibit A.

Unit 2 similar to the first will be ready by March 1987. This brings the project offer up to 25 MW gross by 1987. A period of time in 1985 is required to confirm the reservoir for the second unit. See diagram 5-2.

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1.2 Additional capacity after 1987 will be negotiated up to a total 80 MW gross capacity. The proposer will develop both the resource and the power plants up to this limit. It is anticipated the third unit to be a 25 MW unit on-line in 1990.

1.3 If, at such time after Units 1 and 2, total capacity 25 MW HELCO desires to purchase geothermal reservoir production to use in electric generating plants, proposer will sell the use of the production on a geothermal steam sales basis. The proposer will sell the use of steam and receive the condensate to inject for the steam sales price.

1.4 It is anticipated the reservoir is capable of producing 200 MW of electric power generation. Therefore, since reservoir production is available to generate more than the 80 MW, additional geothermal steam energy will be available for purchase by HELCO in accordance with 1.3.

ADDITIONAL GEN. ACCEPTABLE FROM OTHERS WITH HELCO GEN.

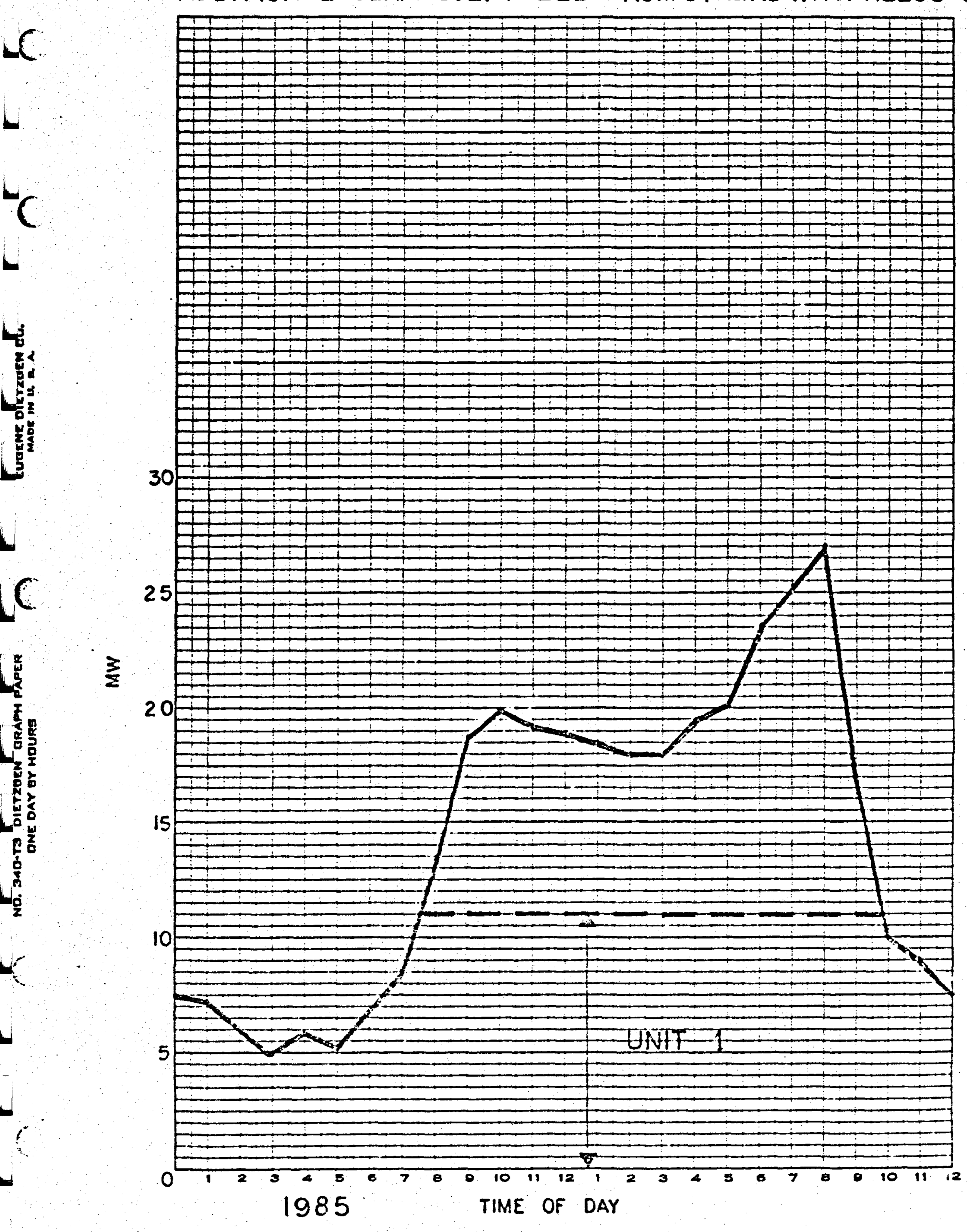
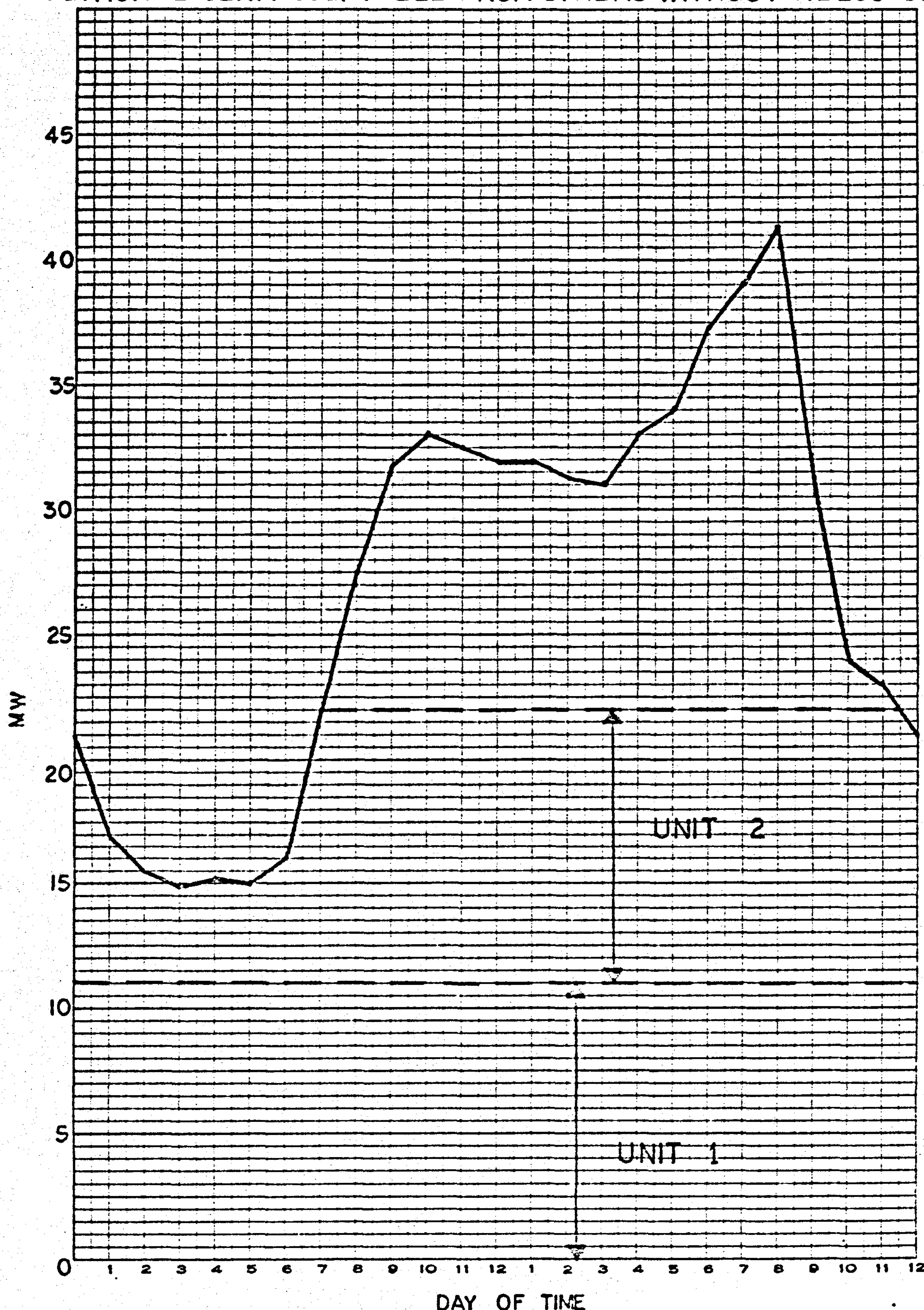




DIAGRAM 5-1

ADDITIONAL GEN. ACCEPTABLE FROM OTHERS WITHOUT HELCO GEN.




APPROXIMATE 1987

DIAGRAM 5-2

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## 2.0 ANTICIPATED COST

At this stage of the project development the anticipated costs are estimates and these are used to develop the energy sales price. The anticipated costs form the basis of the present offer.

The proposer views this development as having two major parts. The first part is delivering geothermal production to the power plant and receiving it back for injection. The second part is the power plant to generate electric energy.

### 2.1 Resource Production

Estimated capital costs associated with the resource production for Unit 1.

| Item | Dollars |
|---|---|
| Production Wells | 5,000,000 |
| Gathering, Flash and Injection Systems | 1,875,000 |
| Injection Well | 750,000 |
| TOTAL | 7,625,000 |

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## 2.2 Power Plant

| | |
|---|---|
| Unit 1 12.5 MW Gross | $15,250,000 |

## 3.0 ENERGY SALES PRICE

These sales prices correspond to the project offer of Section 1.0. The basic offer provides as a first phase an electric energy sale of up to 155 million kWh per year. The second phase is an option for HELCO to purchase the use of the geothermal production. There are basic conditions which apply generally to the sales prices. These elements are developed further in the following sub sections.

### 3.1 Electric Energy

9.0¢/kwh

### 3.2 Geothermal Resource Production

5.0 ¢/kwh

### 3.3 Sales Conditions

3.3.1 Annual Income

3.3.2 Capacity Factor

3.3.3 Escalation

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## 4.0 ALTERNATIVE OFFERS

These offers are variations on the project offer. They relate to ownership and the participants positions.

### 4.1 Power Plant Unit 1 & 2 Sale

(After Seven Years)

### 4.2 Power Plant Unit 1 & 2 Participation

HELCO is offered the option to participate financially in the power plant capital expenditures.

### 4.3 Sale and Participation

After participating would sell the remainder of Power Plants Unit 1 and 2 after seven years.